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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

**ETM7186 – ADVANCED NETWORK ARCHITECTURES
AND PROTOCOLS**
M.Eng. (Telecommunications)

04 JUNE 2018
2:00 PM – 5:00 PM
(3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages (including this cover page) with 5 Questions only and an Appendix.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

- a. Consider a TCP connection between Host A (sender) and Host B (receiver) over the topology shown in Fig. 1. The bit rate of each link and the processing delay of each intermediate node and Host B are shown in the same figure.

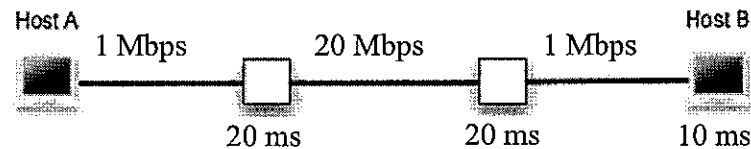


Fig. 1

Assume that packets are lost along the connection with a constant probability, $p = 0.1$. If the packet size is **8000 bits**, estimate the average sending rate of the TCP source based on the

- (i) Periodic packet loss model (by using the inverse square root p -law) [3 marks]
- (ii) Detailed aperiodic packet loss model [3 marks]

Assume a very small size of ACK packet such that its transmission time is negligible.

- b. TCP was initially designed and optimized based on the characteristics of wired networks. When TCP is implemented in wireless networks, its throughput is poorer than expected. The following four proposals provide mechanisms to improve TCP performance over wireless networks. Discuss each of the proposals in terms of their respective working principles, strengths and weaknesses.
- (i) Split TCP [3.5 marks]
 - (ii) Snoop TCP [3.5 marks]
 - (iii) Explicit Loss Notification (ELN) [3.5 marks]
 - (iv) TCP Selective Acknowledgement (SACK) [3.5 marks]

Continued ...

Question 2

- a. Describe the three types of Passive Queue Management (PQM).

[6 marks]

- b. The limiting probabilities $\{\pi_j\}$, of an ergodic Markov chain are often referred to as the *equilibrium* probabilities in the sense that the effect of the initial state distribution $\pi_j^{(0)}$ has disappeared. A 3-state Markov chain is shown in Fig. 2. The transition probability matrix $\mathbf{P}$ consists of elements p_{ij} , which are shown in the diagram.

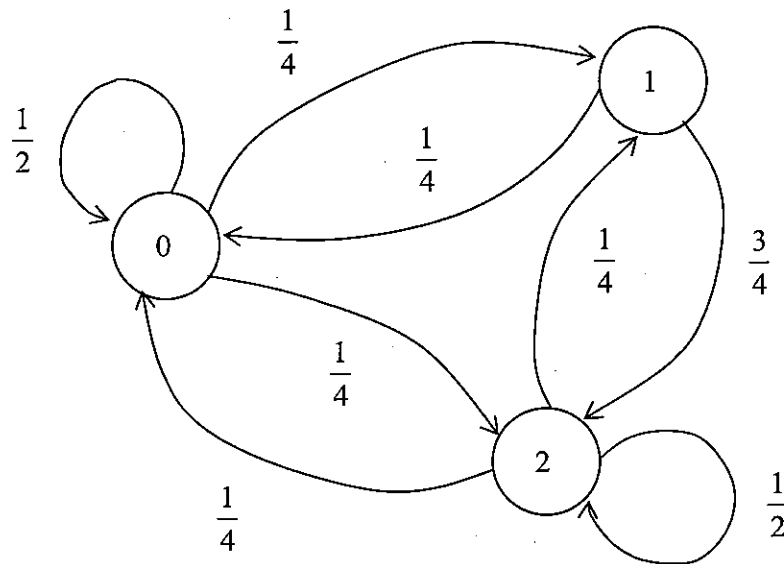


Fig. 2 A Markov chain

- (i) Write down $\mathbf{P}$ in the form of a 3×3 matrix.

[2 marks]

- (ii) The quantities $\{\pi_j\}$ can be uniquely determined through the equations

$$\pi_j = \sum_i \pi_i p_{ij}$$

$$1 = \sum_i \pi_i$$

Solve for $\{\pi_0, \pi_1, \pi_2\}$.

[12 marks]

Continued ...

Question 3

- a. (i) IP multicast services over the Internet face a number of deployment issues, which include the lack of access control in multicast group management. Discuss, with some suitable examples, the problems that could arise from this issue. [4 marks]
- (ii) Application layer multicast (ALM) has emerged as a promising alternative to IP multicast in providing multicast services over the Internet. Differentiate between ALM and IP multicast. [2 marks]
- (iii) Define stretch and stress in the context of ALM. [2 marks]
- b. Differentiate between **centralized** and **distributed** routing algorithms. [4 marks]
- c. Applying **Dijkstra's** algorithm to the graph in Fig. 3 below, find the **shortest paths** from
- (i) vertex 1 to 2
 - (ii) vertex 1 to 3
 - (iii) vertex 1 to 4.

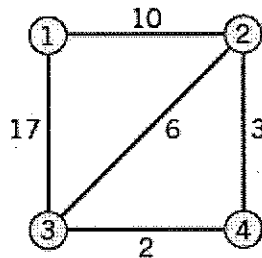


Fig. 3

[8 marks]

Continued ...

Question 4

- a. A scheduling discipline allocates a share of the link capacity and output queue buffers to each connection it serves. For best-effort traffic, the desirable scheduling objective is to provide max-min fair share allocation.
- Compute the max-min fair allocation for a set of four sources with demands 2, 4, 10, 4 and weights 0.5, 4, 2.5, 1 when the resource has a capacity of 16. [8 marks]
 - Generalized processor sharing (GPS) is an ideal scheduling discipline that provides max-min fair share allocation. Consider a weighted round-robin (WRR) scheduling discipline which tries to emulate the ideal GPS. Suppose connections A, B and C have mean packet sizes of 50, 1000 and 1500 bytes, and weights 0.25, 0.75 and 1.0, respectively. Calculate the number of packets that each connection should be served in each round by a WRR scheduler. [2 marks]
- b. The Internet **Diffserv** architecture provides service differentiation, i.e., the ability to handle different classes of traffic in different ways within the Internet in a scalable manner. Fig. 4 shows a simple example of Diffserv network.

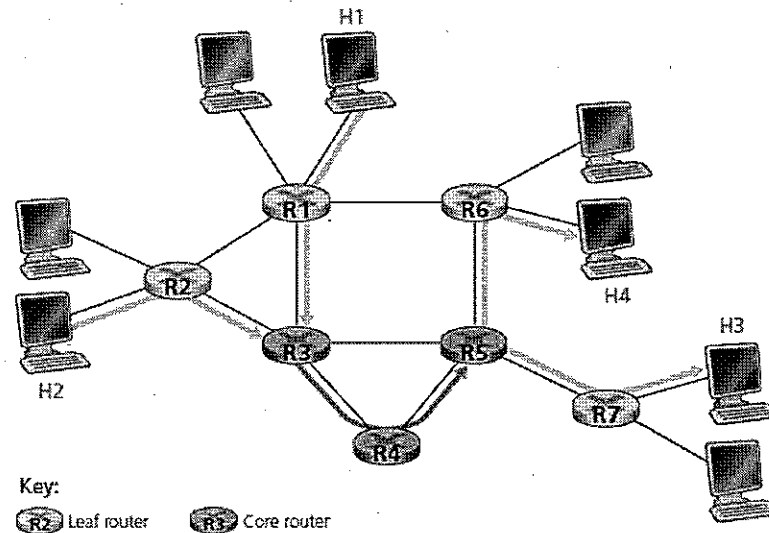


Fig. 4 A Diffserv network

With the help of Fig. 4 and perhaps some examples, explain the followings.

- Edge** function and its purpose. [4 marks]
- Core** function and its purpose. [2 marks]
- Per-hop behaviour (PHB)** associated with a packet's class. [4 marks]

Continued ...

Question 5

- a. The following is a statistical analysis on the confidence level of network simulation results. Suppose 10 observations are made from a normal distribution with unknown mean μ . They are: 1.09, 0.50, 0.95, 1.49, 1.89, 1.68, 1.55, 1.58, 1.50, and 1.20. Determine the **90%** confidence level for μ .
(Hint: Use the table provided in the Appendix.)

[5 marks]

- b. Use the **Prim's** algorithm to find the shortest **spanning tree** for the graph in Fig. 5. Determine its **root** and **total length**.

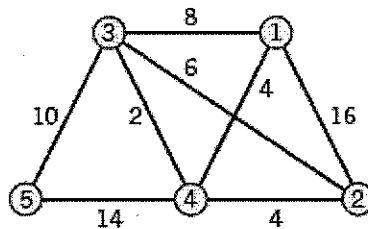


Fig. 5

[11 marks]

- c. (i) Differentiate between **stochastic** and **deterministic** routing algorithms.

[2 marks]

- (ii) Differentiate between **state-dependent (dynamic)** and **state-independent (static)** routing algorithms.

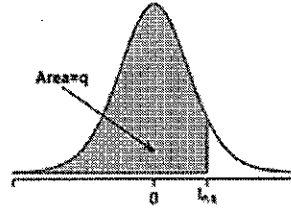
[2 marks]

Continued ...

APPENDIX

Quantiles of the t Distribution

The table gives the value if $t_{n,q}$ - the q th quantile of the t distribution for n degrees of freedom



	$q = 0.6$	0.75	0.9	0.95	0.975	0.99	0.995	0.9975	0.999	0.9995
$n = 1$	0.3249	1.0000	3.078	6.314	12.706	31.821	63.657	127.321	318.309	636.619
2	0.2887	0.8165	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.599
3	0.2767	0.7649	1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4	0.2707	0.7407	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.2672	0.7267	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.2648	0.7176	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.2632	0.7111	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.2619	0.7064	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.2610	0.7027	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.2602	0.6998	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.2596	0.6974	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.2590	0.6955	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.2586	0.6938	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.2582	0.6924	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140

$$\bar{X}(n) \pm t_{n-1, 1-\left(\frac{\alpha}{2}\right)} \sqrt{\frac{S^2(n)}{n}}$$

Useful Formulas

For periodic packet loss model, average throughput, $\bar{X}(p) = \frac{1}{RTT} \sqrt{\frac{3}{2p}}$

For detailed aperiodic packet loss model, average throughput, $\bar{X}(p) = \frac{\frac{1}{p} + \sqrt{\frac{8}{3p} - \frac{5}{3}}}{RTT \left(\frac{3}{2} + \sqrt{\frac{2}{3p} - \frac{5}{12}} \right)}$

End of Paper